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stalks 12 or 18 inches apart upon the rows. Early in July the plant has usually acquired sufficient size to shade the ground and prevent the further growth of grass, and the crop is then "laid by." It is of the first importance that the land should have been kept perfectly clear of weeds up to this time, and in a hot climate the task is often a difficult one.

Simultaneously with the cultivation of cotton, the cultivation of Indian corn, sweet potatoes, &c., proceeds, in order to furnish food for the negroes of the plantation, for the mules or other draught animals, and for a sufficient number of hogs to yield meat for the labourers.

In middle Alabama the cotton plant usually commences flowering early in June, and continues to bloom until frost kills it, bolls continuing therefore to form during several months. The earliest bolls open, in ordinary years, from the 10th to the 15th of August, when the "picking" season commences. This lasts until the cotton is all gathered—until January or even February, if a full crop be made. The bolls continue gradually to open long after frost has prevented the formation of any more. In picking the cotton from the boll, surprising manual dexterity is shown by negroes accustomed to the task from early youth.

The seed cotton, as it is collected into large baskets by the pickers, is carried to the "gin-house" of the plantation, and "ginned;" and when enough of the clean fibre has accumulated, a day or two is devoted by a part of the hands to pressing it with the large wooden "screw" into bales ready for shipment by river to the sea-port.

XI. "Account of Experiments made at Holyhead (North Wales) upon the Transit-Velocity of Waves through the Local Rock Formations." By Robert Mallet, Esq., C.E., F.R.S. Received June 18, 1861.

(Abstract.)

These experiments were made by the author at the joint request of the Royal Society and of the British Association for the Advancement of Science, aided by grants from each of those bodies.

Their object was to ascertain the transit rate or velocity of propagation of waves of elastic compression, analogous to those of na-

tural earthquakes, through the stratified and highly convoluted, laminated, and shattered slate and quartz rocks of the neighbourhood of Holyhead, where the recurrent explosion of very large mines of gunpowder in the Government quarries (for the obtaining of rock for construction of the Asylum Harbour) afforded a valuable opportunity in the production of the requisite impulses for generation of the wave.

The author had previously determined experimentally (at Killiney Bay, in Ireland) the transit velocity of such waves in wet sand, and in highly-shattered and more solid granite; media presenting, probably, the extremes of slowness and of fastness of wave transit. It was still desirable to determine this for rock, not only minutely crystalline, but also stratified, convoluted, and generally highly perplexed and heterogeneous in internal structure. The instrumental means employed were generally similar to those adopted previously at Killiney Bay, with suitable modifications consequent upon the great charges of powder fired, which at these quarries have reached as much as nine tons at a single blast or mine. The seismoscope (see Trans. Brit. Assoc. 1851, Second Report on Facts of Earthquakes, R. Mallet, p. 277, &c.) was placed upon a levelled table of solid rock at a suitable station (shown on the map and sections that accompany the paper), and with it the chronograph and galvanic apparatus, by which, on making contact, by the author's pressing his hand upon the lever of the latter instrument, the mine at the quarry, distant in all cases about a mile, was ignited, and the time that elapsed between the starting of the elastic wave from the impulse of the explosion to its arrival at the observer and visibility in the field of the seismoscope was recorded. This registered time was subject to three principal corrections, the respective coefficients of which are also determined experimentally. The instruments admitted of time determinations to within nearly $\frac{7}{1000}$ of a second. The range over which the wave traversed was accurately obtained in length for each separate experiment. A constant distance from the observing station $= 4584 \cdot 80$ feet, up to a fixed point near the quarries, was obtained with precision, in the first instance, by trigonometrical operations, upon a measured base of 1432 feet. The distance of the mean centre of each mine or heading was subsequently measured in a right line to this fixed point, and the angle made by

the latter with the former line determined, whence the direct distance between the mean centre of each particular "heading," or mine, and the observer's station, was trigonometrically deduced.

The following table gives part of the results obtained from six good experiments.

TABLE.

No. of experiments.	Weight of powder exploded.	Total distance of mean centre of heading from observer.	Total observed time of transit.	Observed rate of transit per second, uncorrected.	Final corrected transit rates observed.
	lbs.	feet.	seconds.	feet per second.	feet per second.
1	3,200	6582·93	7·346	896·12	1016·200
2	2,100	5476·57	5·658	967·93	1098·958
3	2,600	6377·14	6·524	977·26	1109·483
4	6,200	6403·48	5·455	1173·87	1331·168
5	12,000	5038·13	4·161	1210·79	1373·035
6	4,400	5228·59	5·249	996·11	1129·598

One very remarkable result is at once apparent on inspecting this table—viz. that the transit rate tends to increase in velocity with the increased quantity of powder fired; in other words, that the loss of velocity in the same rock is less in some proportion as the force of the originating impulse is greater, and so its amplitude greater at starting. This is seen if the experiments be arranged in the order of increased weight of powder.

No. of experiment	2.	3.	1.	6.	4.	5.
Weight of powder	2100 lbs.	2600 lbs.	3200 lbs.	4400 lbs.	6200 lbs.	12,000 lb.
Uncorrected transit velocities . .	967·93	977·26	896·12	996·11	1173·87	1210·79

Experiment No. 1 forms the only apparent exception, and even there the departure is not large.

This fact, now for the first time (so far as the author knows) experimentally proved, appears remarkably in coincidence with the theoretical researches of Mr. Earnshaw.

The general mean transit velocity derivable from all the experiments taken together gives 1176·407 feet per second for the rate. The results, however, obviously form two groups—viz. Nos. 1, 2, 3 and 6 from the smaller, and Nos. 4 and 5 from the greater charges of powder. The mean from the first four is 1088·5597 feet per second; that from the two last 1352·1015 feet per second; and

taking a mean of means from both, we obtain 1220·3306 feet per second as the mean transit velocity of propagation, in the rocks experimented on, of wave pulses due to the impulse of explosions of not exceeding 12,000 lbs. of powder.

The first mean from the smallest charges is that which must be compared with the Killiney Bay experiments. It thus appears that the wave velocity in highly contorted and foliated rock is very low, and is intermediate between the transit rate in wet sand and in discontinuous granite, or

In wet sand = 824·915 feet per second.

In contorted and stratified rock, quartz, and slate = 1088·559 feet per second.

In discontinuous granite = 1306·425 feet per second.

In more solid granite = 1664·574 feet per second.

The general mean obtained, 1220·33 feet per second, or 13·877 statute miles English per minute, co-ordinates, as might be expected, with the carefully made deductions of Nöggerath and of Schmidt from the actual earthquakes of the Rhine and of Hungary, as well as with those of the author from the great Naples earthquake of 1857.

In experimenting with these great explosions the author was enabled to observe, by means of the seismoscope, that the advent of the great wave of impulse (which was sometimes sufficient to make the mercury sway visibly in the trough of the instrument) was preceded by rapidly augmenting tremors, quite like those which very generally precede the great shock in natural earthquakes.

The wave transit in these experiments was made partly in slate rocks and partly in quartz formations, which, though lithologically and geologically distinct, are nearly identical in wave propagative power (as this author has shown by a train of special experiments at the conclusion of the paper), differing not more than in the ratio of 0·576 for the slate to 0·558 for the quartz. The author concludes by pointing out several deductions having interest to general physics, and some of the special relations of the results to Seismology and Physical Geology.